On information acquisition by buyers and information disclosure by sellers

On Information Acquisition by Buyers and Information Disclosure by Sellers*

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Abstract

I consider a monopolistic-pricing model in which the buyer does not know his valuation at the outset. The seller may induce him to acquire information even though she could easily disclose sufficient information herself.

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1 Introduction

Prior to trade, a seller can often disclose information that is relevant for the buyer's valuation, and the buyer himself can acquire information on his own. A seller of a new product, for instance, could provide a video demonstration, and potential buyers could inspect customer reviews. This paper shows that sellers might prefer buyers to acquire information, rather than disclosing sufficient information themselves.

Pre-trade information can have a social and a private value: On the one hand, it may allow to examine whether the buyer's valuation is larger than the seller's, and thus whether trade would be efficient. On the other hand, it may allow the buyer to check whether his valuation is larger than the price, and thus whether trade would be profitable for himself. This latter aspect potentially forces the seller to command a low price, and is the relevant aspect in my analysis.

If information acquisition entails low costs and the buyer is to dispense with it, the private value of information must be low as well. In contrast, if the seller tailors her offer so as to induce information acquisition, the private value of any further information need not be low, provided that the buyer cannot acquire further information at equally low costs. For this reason, the seller may prefer the buyer to acquire information—even if she could easily disclose sufficient information herself. The result suggests that regulation requiring comprehensive information disclosure may promote welfare, because such regulation potentially prevents costlier information acquisition on the side of the consumers.

A recent literature studies information disclosure by a mechanism designer (e.g., Bergemann and Pesendorfer 2007; Lewis and Sappington 1994; Li and Shi 2015). A different literature studies information acquisition by agents (e.g., Crémer and Khalil 1992; Crémer et al. 1998; Shi 2012). To the best of my knowledge, the two issues have not been studied in combination before. The seminal paper on information disclosure by Milgrom (1981) differs in that, in my model, the seller does not know how the information affects the buyer's valuation. This assumption reflects the buyer having privately known tastes, needs, etc., and follows the recent mechanism-design literature on disclosure.

2 Model

A buyer and a seller can exchange one unit of a good. The seller's valuation is zero. The buyer's valuation is v. If the good is traded at price p, the seller's payoff is p and the buyer's payoff $v - p$.

The seller proposes the price as a take-it-or-leave-it offer. At that date, both parties do not know the buyer's valuation. Both believe that v equals v_H with probability μ and v_L with probability $1 - \mu$, where $\mu \in (0, 1)$, $v_H > v_L > 0$, and $\mu v_H > v_L$. Let $\tilde{v}$ be the corresponding random variable.

When the seller proposes the price, she can disclose arbitrary information about the valuation to the buyer. Specifically, she can choose a signal $\tilde{s}$ of $\tilde{v}$ and let the buyer inspect it. A signal is characterized by a signal-realization space and conditional distributions over signal realizations given the valuation. The buyer observes both the chosen signal and its realization. A *perfect* signal, for example, has conditional distributions whose supports are disjoint across v_L and v_H, so that the buyer fully learns his valuation. A *null* signal, in contrast, has conditional distributions that are identical across v_L and v_H, so that the buyer learns nothing.

After the seller proposes the price and discloses information, before deciding whether or not to buy, the buyer can acquire information on his own. This information is represented by a particular signal of $\tilde{v}$, denoted by $\tilde{s}'$. The possible realizations of $\tilde{s}'$ are s'_H and s'_L. Conditional on the valuation being high, $\tilde{s}'$ is correct with probability one, $\Pr[s'_H|v_H] = 1$. Conditional on the valuation being low, $\tilde{s}'$ may be wrong, $\Pr[s'_H|v_L] = \gamma \in (0, 1)$. Note that upon observing signal realization s'_L, the buyer thus knows for sure that his valuation is low.

Information acquisition entails a cost of $c > 0$ for the buyer. Information disclosure, in contrast, entails zero costs for both parties. The seller can choose any signal $\tilde{s}$, with the only restriction that conditional on the valuation, $\tilde{s}$ is independent of $\tilde{s}'$. Her objective is to choose the signal and propose the price such that her expected payoff is maximized.

3 Analysis

3.1 Preliminaries

Gross of potential information acquisition expenses, the social surplus is v if trade takes place and zero otherwise. Hence, trade is always efficient, regardless of the buyer's valuation. Any information about the valuation is thus socially worthless. In the first-best, the good is consequently traded with certainty, and the buyer does not waste resources for information acquisition. Whether or not the seller discloses information is then irrelevant with respect to surplus, given that disclosure entails no costs.

Suppose information acquisition was impossible. In that case, the seller could obtain the first-best surplus, namely, by charging the price $p = E[\tilde{v}] = v_L + \mu(v_H - v_L)$ and disclosing no information (i.e., choosing a null signal). In the original model, the seller can *not* obtain the first-best surplus, unless the information-acquisition cost is prohibitively high. To be precise, suppose the seller charges $p = E[\tilde{v}]$ and chooses a null signal. If, instead of buying immediately, the buyer first acquires information, he will with probability $(1-\mu)(1-\gamma)$ observe s'_L and thus learn that his valuation is low. He could then avoid a loss of $\mu(v_H - v_L)$ by declining the seller's offer. Taking the information-acquisition cost into account, this procedure is strictly better than buying immediately if and only if

$$\mu(1-\mu)(1-\gamma)(v_H - v_L) > c. \tag{1}$$

I assume from now on that (1) holds. Hence, the seller cannot obtain the first-best surplus.

3.2 Deterring information acquisition

My first step is to derive the seller's best price-disclosure strategy that deters information acquisition. In the next section, I show that this strategy may be suboptimal, that is, the seller may be able to obtain a larger expected payoff with a strategy that induces information acquisition.

Given that information acquisition is to be deterred, I can without loss of generality assume that the seller chooses a signal whose possible realizations are B and $\neg B$, such that upon observing B the buyer buys without information acquisition and upon $\neg B$ he declines without information acquisition. I may furthermore assume that $\neg B$ is displayed with probability zero if the valuation is high, $\Pr[\neg B|v_H] = 0$. To see the latter, note that shifting probability mass from $\neg B$ to B conditional on v_H increases the buyer's posterior expected valuation upon B and decreases it upon $\neg B$, so that he is still willing to buy and decline, respectively.

The seller's choice variables are thus the price and the conditional distributions over the signal realizations B and $\neg B$. Rather than considering the conditional distributions, I will focus on the distribution over the buyer's posterior beliefs. It is well-known that this approach entails no loss of generality (see, e.g., Kamenica and Gentzkow 2011). Specifically, let $x := \Pr[v_H|B]$ be the buyer's posterior belief that his valuation is high upon observing signal realization B. (Note that $\Pr[v_H|\neg B]$ is already fixed to zero, given $\Pr[\neg B|v_H] = 0$.) Let $\beta := \Pr[B]$ be the unconditional probability with which this signal realization is displayed. Then, every combination (x, β) with $x, \beta \in [0, 1]$ such that the expected posterior equals the prior,

$$\beta x = \mu, \tag{2}$$

corresponds to a pair of conditional distributions $\Pr[\cdot|v_H], \Pr[\cdot|v_L]$ over the signal realizations, and vice versa.

By (2), β is fixed to μ/x. A feasible price-disclosure strategy is thus a combination (p,x) with

$$x \in [\mu, 1] \tag{3}$$

that satisfies the following incentive conditions: First, upon observing B the buyer must buy without information acquisition. Hence, this must be better than declining without information acquisition,

$$v_L + x(v_H - v_L) - p \geq 0, \tag{4}$$

and than acquiring information and then buying if and only if the buyer-signal, $\tilde{s}'$, displays s'_H:

$$\begin{aligned} & v_L + x(v_H - v_L) - p \geq \Pr[s'_H|B]\left[v_L + \Pr[v_H|s'_H, B](v_H - v_L) - p\right] - c \\ \Leftrightarrow\, & v_L + x(v_H - v_L) - p \geq [x + \gamma(1-x)]\left[v_L + \frac{x}{x+\gamma(1-x)}(v_H - v_L) - p\right] - c \\ \Leftrightarrow\, & (1-\gamma)(1-x)(v_L - p) + c \geq 0. \end{aligned} \tag{5}$$

Second, the buyer must decline without information acquisition upon observing $\neg B$. This condition will be satisfied automatically, and can thus be ignored.

Consider now the seller's objective. Her expected payoff from a price-disclosure strategy (p,x) that satisfies (3)–(5) is $(\mu/x)p$. Hence, the best strategy is the solution to

$$\max_{p,x} \frac{\mu}{x} p \quad s.t. \quad (3)\text{–}(5). \tag{6}$$

The following lemma characterizes the best strategy for low information-acquisition cost levels, and states the seller's corresponding expected payoff.

Lemma 1. *There exists a cutoff level of the information-acquisition cost $c^* > 0$ such that for all $c < c^*$, the best price-disclosure strategy that deters information* *acquisition is given by*

$$p^* := v_L + x^*(v_H - v_L) \quad \textit{and} \quad x^* := \frac{1}{2} + \sqrt{\frac{1}{4} - \frac{c}{(1-\gamma)(v_H - v_L)}}.$$

The seller's corresponding expected payoff, as a function of the information-acquisition cost, is

$$\Pi^*(c) := \frac{\mu}{\frac{1}{2} + \sqrt{\frac{1}{4} - \frac{c}{(1-\gamma)(v_H - v_L)}}} v_L + \mu(v_H - v_L).$$

Proof. I first show that (5), the no-information-acquisition constraint, holds with equality at the optimum. Suppose not. Then, the seller would choose p such that (4), the individual-rationality condition, holds with equality. This implies that the optimal x would be strictly larger than μ, for otherwise (5) was violated by condition (1). But then slightly reducing x and p such that (4) still holds with equality would raise the seller's expected payoff and satisfy all constraints.

Since (5) holds with equality and $c > 0$, the optimal x satisfies $x < 1$ and the optimal price satisfies

$$p = v_L + \frac{c}{(1-\gamma)(1-x)}.$$

Moreover, problem (6) can be reformulated as

$$\max_{x \in [\mu, 1)} \frac{\mu}{x} \left[v_L + \frac{c}{(1-\gamma)(1-x)} \right] \quad s.t. \quad x(v_H - v_L) - \frac{c}{(1-\gamma)(1-x)} \geq 0. \tag{7}$$

The objective function in problem (7) is strictly convex on $[\mu, 1)$. Hence, the optimal x is either the lowest possible value, μ, or the highest possible value, the root x^* of the constraint in (7). With $x = x^*$, the optimal price is p^* and the value of the objective function $\Pi^*(c)$. With $x = \mu$, in contrast, the value of the objective function is

$$\Pi(c) := v_L + \frac{c}{(1-\gamma)(1-\mu)}.$$

Now,

$$\lim_{c \searrow 0} \Pi^*(c) = \mu v_H > \lim_{c \searrow 0} \Pi(c) = v_L,$$

where the inequality holds by assumption. By continuity, the inequality holds for a whole interval of information-acquisition cost levels, concluding the proof. □

Under the price-disclosure strategy in the lemma, the buyer is indifferent whether to acquire information. That is, the value of information to him is exactly equal to the information-acquisition cost, c. The value of information to the buyer is $(1-\gamma)(1-x)(v_L - p)$, $(1-\gamma)(1-x)$ being the probability with which he would observe s'_L and thus learn that his valuation is low, and $(v_L - p)$ being the possible loss that he could then avoid by declining the offer.

Now, with the price p^* the seller gets the entire expected surplus conditional on trade taking place. In particular, $p^* > v_L$, so that the buyer indeed makes a loss if he buys with the low valuation. For low c, the buyer must therefore be relatively certain to have the high valuation, given that he is to dispense with information acquisition. Indeed, in the limit, when $c \searrow 0$, the seller must fully remove all uncertainty (i.e., choose $x = 1$, respectively, a perfect signal). In that case, trade takes place only if the buyer has the high valuation.

3.3 Deterring information acquisition may be suboptimal

The main result is that deterring information acquisition may be suboptimal:

Proposition 1. *There exists a cutoff level of the information-acquisition cost $\hat{c} > 0$ such that for all $c < \hat{c}$ there exists a price-disclosure strategy that induces information acquisition and yields the seller an expected payoff strictly larger than $\Pi^*(c)$.*

Proof. Consider the following strategy. The seller discloses no information (i.e., chooses a null signal), and proposes the price

$$\hat{p} := v_L + \frac{\mu}{\mu + (1-\mu)\gamma}(v_H - v_L) - \frac{c}{\mu + (1-\mu)\gamma}.$$

If the buyer then acquires information (and buys if and only if the buyer-signal displays s'_H), his expected payoff is

$$\begin{aligned}
&\Pr[s'_H][v_L + \Pr[v_H|s'_H](v_H - v_L) - \hat{p}] - c \\
=& [\mu + (1-\mu)\gamma](v_L - \hat{p}) + \mu(v_H - v_L) - c \\
=& 0.
\end{aligned}$$

In contrast, if he buys immediately, without acquiring information, his expected payoff is

$$\begin{aligned}
&v_L + \mu(v_H - v_L) - \hat{p} \\
=& -\frac{1}{\mu + (1-\mu)\gamma}\left[\mu(1-\mu)(1-\gamma)(v_H - v_L) - c\right] \\
<& 0,
\end{aligned}$$

where the inequality holds by condition (1). Thus, the buyer strictly prefers acquiring information over buying immediately, and is indifferent between acquiring information and declining immediately. So suppose he acquires information. The seller's expected payoff, as a function of the information-acquisition cost, is then

$$\hat{\Pi}(c) := \Pr[s'_H]\hat{p} = (1-\mu)\gamma v_L + \mu v_H - c.$$

Now,

$$\lim_{c \searrow 0} \hat{\Pi}(c) = (1-\mu)\gamma v_L + \mu v_H > \lim_{c \searrow 0} \Pi^*(c) = \mu v_H.$$

By continuity, the inequality holds for a whole interval of information-acquisition cost levels, concluding the proof. □

Deterring information acquisition is very expensive if the information-acquisition cost is low: the value of information to the buyer must be almost zero. According to Lemma 1, the seller will then inform the buyer almost perfectly, and thus sell almost only if the valuation is high. In contrast, if the buyer acquires information the seller can extract the entire expected surplus and yet sell with a certain probability also if the valuation is low—even though the buyer will then make a loss. In particular, upon information acquisition, the value of any further information does not have to be zero, since there *is* no further information to acquire.

Remark 1. If the buyer-signal may be wrong also conditional on the valuation being high, $\Pr[s'_H|v_H] < 1$, the buyer might decline upon information acquisition even if his valuation is high, which makes inducing information acquisition less attractive.

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